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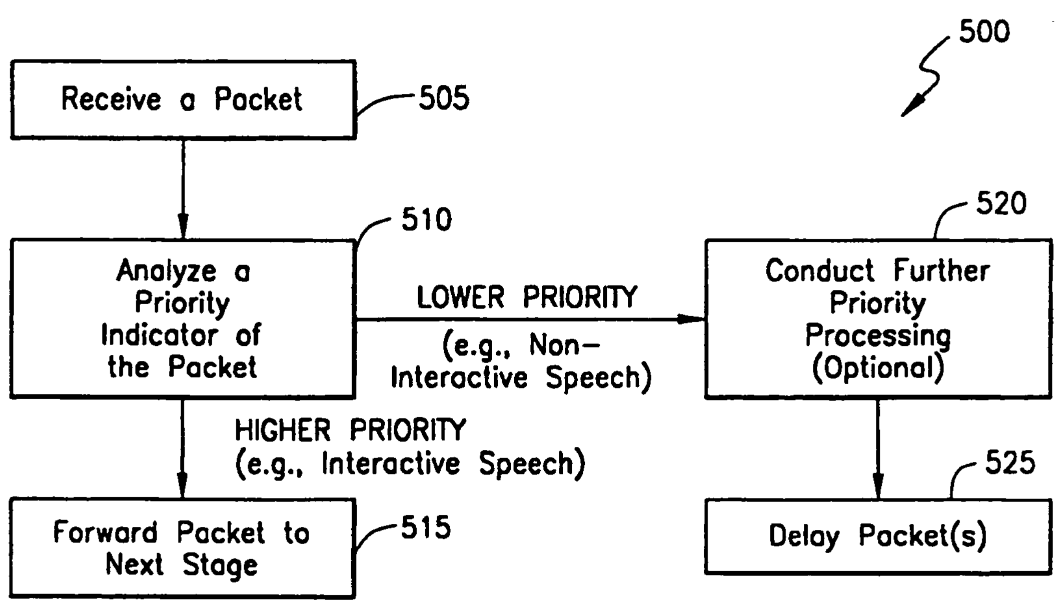

(57) Abstract

A method (500), apparatus (220), and transmission format (400) enables packets (400) carrying different types of information (406) to be assigned different priority levels (402) and to be forwarded accordingly. In one embodiment, packets include an indication as to whether they have a high priority (e.g., interactive speech), a low priority (e.g., non–interactive speech), etc. Packets with low priority are queued and delayed (525) until packets with a high priority are forwarded (515). Examples of non–interactive speech include voice mail, computer–generated menus, e–mail to/from speech, etc. In one particular embodiment, the system identification block (685, 695) of TFO messages (680, 690) is populated with a priority level indication.

PRIORITY TRANSMISSION FOR VARIOUS TYPES OF SPEECH IN NETWORK TRAFFIC

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates in general to the field of network communications, and in particular, to establishing and implementing priority delays for various traffic types, such as, for example, non-interactive speech traffic.

Description of Related Art

Today's mobile wireless systems provide subscribers with many new and exciting features. These features include, for example, caller identification, voice mail, message transmission, and multiparty calling. Additionally, wireless service is becoming more and more affordable due, in part, to more efficient use of the available spectrum. One of the technologies driving these improvements is the implementation of digital transmission. Digital transmission enables more efficient use of the available spectrum as well as providing the ability to implement packet-based distribution and/or transmission.

The introduction of General Packet Radio Service (GPRS), Enhanced Data rates for GSM Evolution (EDGE), and Adaptive Multi-Rate (AMR) speech codecs in the Global System for Mobile Communications (GSM) standard creates increased and variable bandwidth as compared to the current services. These and other factors further encourage the implementation of packet-based distribution and/or transmission. However, no packet-based transmission solution for GSM Base Station Subsystems (BSSs) for Public Land Mobile Networks (PLMNs) is known today. Thus, no approaches for accommodating fluctuations and peak bandwidth demands of a GSM system when using packet-based technologies are known.

For office solutions, on the other hand, systems are under development that may use conventional Local Area Network (LAN)/Intranet infrastructures within a company (e.g., Internet Protocol (IP) transmission) for transmitting voice, data, etc. in packet form. The quality of service (QoS) issue, however, is not addressed beyond over-provisioning the infrastructure with resources or relying on other QoS

mechanisms that are intrinsically supported by the LAN/Intranet infrastructure of the company. Unfortunately, this approach is inadequate for GSM systems because bandwidth is significantly more expensive with GSM systems than with LAN/Ethernet technologies.

SUMMARY OF THE INVENTION

The deficiencies of the prior art are overcome by the method and system of the present invention. For example, as heretofore unrecognized, it would be beneficial to be able to efficiently and economically accommodate bandwidth demands in GSM systems with packet-based technology using delay priority routing and/or transmitting. In fact, it would be beneficial if, for example, different priorities were assigned to packets carrying interactive speech than to those carrying non-interactive speech.

In one exemplary embodiment, information transmitted in time slots (TSs) from mobile stations (MSs) to a base transceiver station (BTS) are received and decoded in transceivers (TRXs). The TRXs format the information into IP packets and send them to an internal router. The internal router receives the packets and stores them in memory. Each packet includes a priority level indication that is analyzed at the router. Packets with a lower priority level (e.g., corresponding to non-interactive speech) are delayed while packets with a higher priority level (e.g., corresponding to interactive speech) are forwarded without such delay.

Interactive speech includes, for example, verbal conversations between two people in real time. Examples of non-interactive speech include voice mail, computer-generated menus, e-mail to/from speech, etc. In one particular embodiment, the priority level indication analysis and forwarding in accordance with the present invention is used in conjunction with tandem free operation (TFO) of speech codecs in a GSM system. Specifically, the system identification block of TFO request and acknowledgment messages may be populated with the priority level indication. The TFO functionality of the network may therefore detect the "system" identifier to be a priority level indication and handle the packets accordingly.

An important technical advantage of the present invention is that it enhances packet-based routing/transmitting in GSM systems.

Another important technical advantage of the present invention is the ability to optimally utilize available bandwidth when routing/transmitting interactive speech and non-interactive speech by prioritizing the interactive speech ahead of the non-interactive speech.

Yet another important technical advantage of the present invention is the ability to utilize TFO by including a priority indication in the system identification block of, for example, request and acknowledgment messages.

The above-described and other features of the present invention are explained in detail hereinafter with reference to the illustrative examples shown in the accompanying drawings. Those skilled in the art will appreciate that the described embodiments are provided for purposes of illustration and understanding and that numerous equivalent embodiments are contemplated herein.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method, system, and transmission format of the present invention may be had by reference to the following detailed description when taken in conjunction with the accompanying drawings wherein:

FIGURE 1 illustrates a portion of an exemplary wireless network system in which the present invention may be advantageously implemented;

FIGURE 2 illustrates an exemplary arrangement of transceivers and a router in accordance with the present invention;

FIGURE 3A illustrates an exemplary transmission delay diagram before activating priority transmission;

FIGURE 3B illustrates an exemplary transmission delay diagram after activating priority transmission in accordance with the present invention;

FIGURE 4A illustrates an exemplary packet having a priority transmission indication in accordance with the present invention;

FIGURE 4B illustrates an exemplary packet router for transmitting prioritized packets in accordance with the present invention;

FIGURE 5 illustrates a method in flowchart form for forwarding received packets according to priority levels of the received packets in accordance with the present invention;

FIGURE 6A illustrates an exemplary handling of an MS-to-MS call with tandem free operation in accordance with the present invention;

FIGURE 6B illustrates an exemplary tandem free operation request message;

FIGURE 6C illustrates an exemplary tandem free operation acknowledgment message;

FIGURE 6D illustrates an exemplary tandem free operation request message with a priority level indication in accordance with the present invention; and

FIGURE 6E illustrates an exemplary tandem free operation acknowledgment message with a priority level indication in accordance with the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the present invention and its advantages are best understood by referring to FIGURES 1-6E of the drawings, like numerals being used for like and corresponding parts of the various drawings.

Aspects of the GSM standard will be used to describe a preferred embodiment of the present invention. However, it should be understood that the principles of the present invention are applicable to other wireless communication standards (or systems), especially those that are digital and may transmit information in packets, such as, e.g., the Digital Advanced Mobile Phone System (D-AMPS) and the Universal Mobile Phone System (UMTS). Furthermore, the principals of the present invention are applicable generally to any packet-based network, whether wireless or wireline.

Referring now to FIGURE 1, a portion of an exemplary wireless network system in which the present invention may be advantageously implemented is illustrated generally at 100. A BTS 110 includes control circuitry and an antenna to cover all or part of one or more cells. The BTS 110 may be a portion of and connected to a wireless network system (not explicitly shown). The BTS 110 may communicate with one or more MSs 130(1), ..., 130(6), ..., 130(x). The BTS 110 communicates on

one or more frequencies, each of which is organized into Time Division Multiple Access (TDMA) frames 120. Each of the frames 120 are further divided into eight (e.g., numbered 0 to 7) TSs. Each MS 130(1), ..., 130(6), ..., 130(x) may transmit one normal burst in each TS.

The BSS (of which the BTS 110 may form all or a part) may be altered to accommodate packet switched transmission. Implementing packet switched transmission within the BSS increases the flexibility and the transmission efficiency when using statistical multiplexing. IP may be utilized, and priority bits in an IP header may be used to introduce QoS in an IP network. When introducing packet-based transmission into a GSM BSS, the delay requirements of GSM should met. Currently, speech information is the most delay sensitive traffic, and the present invention therefore advantageously places speech into the highest delay priority class in one exemplary embodiment. Other services/information, which do not demand as strict delay requirements (e.g., non-transparent data), are placed into lower priority classes that have variable delay by default.

The improvement with the usage of different delay priorities, however, will be limited because the transmitted traffic is currently dominated by speech and is likely to continue to be so for a long time. The improvement derived from statistical multiplexing is then limited to the statistics of the speech sources within the network alone, and no additional improvement from different priority levels is achieved (apart from the signaling, which only needs a very low part of the bandwidth in any event). The use of statistical multiplexing of speech is enabled by the implementation of a Voice Activity Detection/Discontinuous Transmission (VAD/DTX) mechanism, which is already implemented in GSM systems.

Depending on the characteristic(s) of the speech sources, different levels of transmission improvement can be achieved with statistical multiplexing. One of the problems, which the present invention addresses and overcomes, relates to the synchronized radio air interface of GSM systems. The synchronized radio air interface creates a very "bursty" behavior for the generated traffic. For instance, all 20 ms blocks of traffic within a cell will be received/decoded on the same TDMA frame (≈4.6 ms). This is also observable in the downlink direction. This "bursty" behavior

may be accommodated by routing in accordance with the principles of the present invention.

Referring now to FIGURE 2, an exemplary arrangement of transceivers and a router in accordance with the present invention is illustrated generally at 200. The arrangement 200 may be, for example, part of the architecture for a GSM BTS (e.g., the BTS 110 of FIGURE 1). The arrangement 200 uses packet-based transmission (e.g., IP) in this exemplary embodiment. The arrangement 200 includes multiple TRXs. The TRXs (e.g., TRX1 210(1), TRX2 210(2), TRX3 210(3), ..., TRXx 210(x)) are connected (e.g., by way of lines 215(1), 215(2), 215(3), ..., 215(x)) to a router 220. The router 220 may output packets (directly or indirectly) to the wireless network system via an Abis interface 230.

Each TRX (e.g., TRX1 210(1), ..., TRXx 210(x)) may receive an information unit (e.g., a speech frame) from an antenna system (not explicitly shown) of the BTS 110 transmitted from one of the MSs (130(1), ..., 130(x)) (of FIGURE 1). An information unit may be a packet of a general nature, a message of some type, a speech frame, etc. In a GSM embodiment, a speech frame is composed of eight (8) bursts on a single time slot over eight (8) TDMA frames. After the eight (8) bursts have been received, they may be combined into a single speech frame. For example, TRX1 210(1) may receive a speech frame from the MS 130(1) in TS0 over 8 frames 120, TRX6 210(6) (not shown) may receive a speech frame from the MS 130(6) in TS5 over 8 frames 120, and TRXx 210(x) may receive a speech frame from the MS 130(x) in a TS over 8 frames that are on a different frequency than the frequency of the frames 120. Thus, in this embodiment, when the eighth (8th) burst on TS0 is received, de-interleaved, and decoded in TRX1 210(1) in the correct multi-frame position (e.g., into a speech frame in a GSM embodiment), it may be formatted into an IP-type packet and sent to the internal router 220 of the BTS 110.

By way of example and not limitation, assuming that for each TS there is an active call with speech activity, then a speech frame is received in each TRX (TRX1 210(1), ..., TRXx 210(x)) in TS0. Thus, each TRX (TRX1 210(1), ..., TRXx 210(x)) sends one IP packet to the router 220 approximately simultaneously. Consequently, the BTS 110 internal bandwidth between each TRX and the router 220 (e.g., on lines

215(1), 215(2), 215(3), ..., 215(x)) is preferably sufficiently high so that the whole of each packet may be sent before packets corresponding to TS1 need to be sent in order to avoid internal queuing of packets within the individual TRXs. In a GSM embodiment, each packet is therefore sent within one burst time frame (≈0.6 ms). Consequently, if the bandwidth of the Abis interface 230 is less than the x*bandwidth of the internal buses (e.g., the lines 215(1), 215(2), 215(3), ..., 215(x)), the packets may need buffering and may begin to queue in the router 220 before transmission on the Abis interface 230. Typically, the bandwidth on the Abis interface 230 is 2 Mbps (E1) or 1.5 Mbps (T1) while the bandwidth on the internal buses is greater than 2 Mbps.

Generally, absent the benefits of the present invention, all packets from TS0 that originate from the TRXs (TRX1 210(1), ..., TRXx 210(x)) are sent before any packets from TS1 are sent. These packets from TS1 are ready one burst time frame (≈0.6 ms) after TS0. Consequently, the packets of TS1 need to be buffered until all the packets of TS0 have been sent.

Referring now to FIGURE 3A, an exemplary transmission delay diagram before activating priority transmission is illustrated generally at 300. The arrangement 200 and the diagram 300 may be used together to describe the effect(s) of transport delay. In diagram 300, the queuing and the Abis transmission delay together are denoted "Tabis". The Tabis is a function of the speech activity (e.g., speech=1, non-speech=0), TS number (e.g., 0, 1, 2, ..., 7), number of TRXs (e.g., x), and, of course, whether or not there is an active call. By way of example and not limitation, 100% of the available TSs are assumed to carry a call.

In GSM systems without packet-oriented transmissions, the "round-trip delay" for Abis is, when using 16 kbps circuit-switched connections, 23.85 ms. This same requirement is preferably achieved in an exemplary embodiment using packet-oriented transmission. The distribution of the delays, however, are different. For example, the *Tabisd* (Tabis downlink) may be less than 17.4 ms while the *Tabisu* (Tabis uplink) may be more than 4.0 ms. If a symmetrical traffic load is assumed, then the *Tabisu*=*Tabisd*=12 ms. In the description above and in FIGURE 3A, regular 20 ms time intervals are used to describe the timing over the GSM radio interface. To be

more precise, the GSM radio interface introduces a jitter due to the multiplexing of the Slow Associated Control Channel (SACCH) logical channel on the same physical channel. Consequently, the intervals are cyclic on a multi-frame basis. In one embodiment, however, the received speech frames may be buffered to create equal 20 ms intervals or aligned directly to the radio interface timing.

Continuing now with FIGURE 3A, the diagram 300 illustrates exemplary transmission delays given the constraints provided above (e.g., 100% of eight (8) TSs per TDMA frame carry a call) when priority transmission is not activated. "*Tabis0*" is the transmission delay at the router 220 for TS0, which includes x speech frames of information when each TRX (TRX1 210(1), ..., TRXx 210(x)) receives a speech frame. The transmission delay at the router 220 for TS1 is "*Tabis0-0.6 + Tabis1*" for the x speech frames in the TS1 (and those previously sent for TS0). The time for one burst (≈0.6 ms) is subtracted from the delay for TS0 (e.g., Tabis0) when calculating the delay for TS1. Generally, the time for one burst is subtracted for each preceding transmission delay time (e.g., each "*Tabis*"). For TS7, the transmission delay reaches "*Tabis0+Tabis1+ ... +Tabis6 - 7*0.6 + Tabis7*". A standard GSM frame is also shown at ≈4.6 ms and a speech frame interval is shown at ≈20 ms. The graph 300 thus shows exemplary transmission delays as speech frames are received and queued within the router 220 when priorities between/among the speech frames are not established or used for routing.

Advantageously, in accordance with the present invention, speech frames may be prioritized such that those with lower priority are forwarded after those with higher priority. In one exemplary aspect, the principles of the present invention make use of the fact that there exists speech services with varying levels of real-time requirements. For example, while a "live" conversation between two people has a relatively higher priority, communications such as, for example, voice mail, recorded announcement messages, banking over the phone, etc. have a relatively lower priority. Voice mail alone already occupies a large portion of the speech traffic today. These types of non-interactive speech services are also likely to grow. Furthermore, new non-interactive services are likely to be introduced. Such new non-interactive services may include

different types of speech recognition services, such as network-supported, voice-initiated dialing; e-mail to/from speech; etc.

According to the present invention, these different types of calls are identified. After identification, the different types may be assigned differing levels of priority and subsequently queued so that they may be forwarded at different times. For example, calls identified as containing non-interactive speech are placed in a lower delay priority class. Consequently, the available links (e.g., the Abis interface 230) may be better utilized. This increased utilization may be capitalized in a number of ways. For example, it may result in needing a lower bandwidth on the links for a given speech delay or in providing a lower speech delay for a given bandwidth.

Referring now to FIGURE 3B, an exemplary transmission delay diagram after activating priority transmission in accordance with the present invention is illustrated generally at 350 for most TSs. A lower speech delay is exemplified in the graph 350. By way of example and not limitation, all calls in TS0 for all TRXs are assumed to be non-interactive and are placed into a lower delay priority class. "*Tabis0*" is equal to the queuing due to lower delay priority plus the queuing and the Abis interface 230 transmission delay for TS0 for all TRXs. The transmission delay for TS1 is now "*Tabis1*", which is reduced by "*Tabis0-0.6*" as in the diagram 300. Likewise, the total transmission delay for TS2 is reduced to "*Tabis1-1*0.6 + Tabis2*", and the total transmission delay for TS7 is "*Tabis1+ ... +Tabis6 - 6*0.6 + Tabis7*". The transmission delay for the non-interactive communications of TS0, however, significantly lengthens. The effect is thus to reduce the transmission delay for TS1 to TS7 and increase the delay for TS0.

Referring now to FIGURE 4A, an exemplary packet having a priority transmission indication in accordance with the present invention is illustrated at 400. The packet 400 preferably includes multiple blocks. Packets may generally be logically divided into multiple blocks, such as, e.g., a heading block, an information-to-be-transmitted block, etc. The packet 400 is shown to include three (3) blocks although it may contain more or fewer blocks as well, and the blocks may be in any order. The priority level (block) 402 indicates the priority level of the packet. The priority indication may be composed of numerical indications (e.g., 1 to 10), call type

(e.g., interactive speech, non-interactive speech, data, etc.), etc. The packet 400 also includes a destination block 404 (e.g., a telephone number, an IP address, etc.) and an information block 406 (e.g., data, speech, etc.) that holds the information to be transmitted from one location to another.

Referring now to FIGURE 4B, an exemplary packet router for transmitting prioritized packets in accordance with the present invention is illustrated. The router 220 receives speech frames from the TRXs via the lines 215(1), 215(2), 215(3), ..., 215(x). The speech frames may be formatted into IP packets (or any packet-based format) at the TRXs, at the router 220, further into the network after the Abis interface 230, etc., but in a preferred embodiment, the speech frames are formatted into IP packets at the TRXs before arriving at a memory 410. The memory 410 may be any special purpose, general purpose, etc. memory (e.g., a queue, a set of registers, a content-addressable memory, a general RAM, etc.). Each packet 400 received from the lines 215(1), 215(2), 215(3), ..., 215(x) is placed into the memory 410 (e.g., at the memory locations 410(1), 410(2), 410(3), ..., 410(x), respectively). A memory location 410(n) signifies that many more memory locations may be available in the memory 410 for storing the packets 400.

In an alternative embodiment, the number of memories (e.g., memory queues) may be increased by providing a separate memory queue for each of the TRXs/lines 210(x)/215(x) for receiving the packets 400. In another alternative embodiment, the number of separate memory queues may be increased by providing multiple memory queues designated for one or more particular priority levels (e.g., one for interactive speech and another one for non-interactive speech). In yet another alternative embodiment, the number of separate memory queues may be further increased by providing multiple memory queues designated for one or more particular priority levels at each of the TRXs/lines 210(x)/215(x).

A priority analyzer 415 retrieves via a data bus 420 the priority level 402 (either alone or with other portions of a packet 400) from one of the memory locations 410(x) in the memory 410. Continuing with the example provided above with reference to FIGURE 3B, the priority analyzer 415 analyzes the priority level 402 retrieved from the memory location 410(1) and determines that it is classified as non-

interactive speech (e.g., a burst received on TS0). Thus, the corresponding packet 400 is delayed. The priority analyzer 415 next retrieves via the data bus 420 the priority level 402 (either alone or with other portions of a packet 400) from the memory location 410(2) in the memory 410. The priority analyzer 415 analyzes the priority level 402 retrieved from the memory location 410(2) and determines that it is classified as interactive speech (e.g., a burst received on TS1 in the example described above with reference to FIGURE 3B). Thus, the corresponding packet 400 is appropriate for transmission. The priority analyzer 415 informs a packet transmitter 425 via a control signal/line 430 that the packet 400 in the memory location 410(2) is to be transmitted. The packet transmitter 425 retrieves the packet 400 from the memory location 410(2) via the data bus 420 and subsequently forwards the packet 400 onto the Abis interface 230. The priority analyzer continues to analyze the priority levels 402 of the packets 400 received in the memory 410 until, for example, all the packets 400 have been analyzed, additional packets 400 are received, etc.

It should be understood that the elements/logical blocks within the router 220 may be rearranged and/or otherwise altered by one of ordinary skill in the art after reading and understanding the principles of the present invention. For example, the priority analyzer 415 and the packet transmitter 425 may be combined into one discrete and/or functional hardware, software, firmware, etc. unit. In one example of such an embodiment, one unit analyzes each packet 400 and may immediately thereafter forward the analyzed packet onto the Abis interface 230 if appropriate (e.g., if the priority level 402 indicates that the priority is high). It should also be understood that the router 220 and the elements/logical blocks therein (e.g., the memory 410, the priority analyzer 415, the data bus 420, the packet transmitter 425, the control signal/line 430, etc.) need not be discrete hardware units. They may alternatively be, for example, a combination of one or more software modules operating in conjunction with a processing unit (e.g., a digital signal processor, general purpose microprocessor, etc.). Furthermore, the memory 410 need not be within the router 220, and the memory 410 may be shared with other functions and/or processing/storage entities of the BTS 110.

Referring now to FIGURE 5, a method in flowchart form for forwarding received packets according to priority levels of the received packets in accordance with the present invention is illustrated at 500. Flowchart 500 begins when one or more packet(s) are received (block 505). The priority indicator of a packet is analyzed (decision block 510). If the packet has a higher priority level (e.g., interactive speech), then the packet is forwarded to the next stage (block 515). The next stage may be the Abis interface 230 for transmission to the wireless network if, for example, the analyzed priority is the highest possible priority level (e.g., interactive speech in one embodiment). If, on the other hand, the analyzed priority is not the highest priority possible, then the next stage may involve further priority analysis in order to stratify multiple packets according to their respective priority levels.

In one embodiment, interactive speech may be considered a communication between two people in real time while non-interactive speech may be considered verbal communication that is not between two people in real time. Data transmission may be assigned various priority levels (e.g., higher than interactive speech (e.g., for a premium charge from a customer), equal to non-interactive speech, lower than non-interactive speech, etc.). If (in decision block 510) the packet has a lower priority level (e.g., non-interactive speech), then the packet may (optionally) be subjected to further priority processing (block 520) (e.g., to further stratify packets according to finer priority levels). These lower priority packets are delayed (block 525), at least with respect to the higher priority packets that are forwarded to the next stage (in block 515).

Referring now to FIGURE 6A, an exemplary handling of an MS-to-MS call with tandem free operation in accordance with the present invention is illustrated generally at 600. TFO is described in "Inband Tandem Free Operation (TFO) of Speech Codecs; Service Description; Stage 3"; Technical Specification, Digital cellular telecommunications system (Phase 2+); Draft TS 04.53 V.1.3.0 (1998-07), July 1998; GSM; pages 1-32, which is hereby incorporated by reference in its entirety herein. To identify calls as interactive speech or non-interactive speech, for example, TFO protocol may be used in an exemplary embodiment. Several additional advantages of the present invention derive therefrom. For example, because speech

coding in tandem is avoided when using TFO, the speech quality does not decrease as it does with additional encoding/decoding. Consequently, voice may be stored directly in voice mail without the additional speech encoding. Furthermore, frames corrupted over the air interface as well as comfort noise need not be stored, which further reduces memory storage requirements.

Continuing now with FIGURE 6A, an MS A 605 is in communication with an MS B 655 in an environment in which TFO procedures may be utilized. The MS A 605 is in radio communication with a BTS A 610. The BTS A 610 and a Transcoder and Rate Adaptor Unit (TRAU) A 620 are associated with a BSC A 615. The TRAU A 620 includes a TFO_Protocol part 622, an Uplink_TFO (UL_TFO) part 624, and a decoder 626. The TRAU A 620 is connected to a digital network 630, which is also connected to a TRAU B 640. The TRAU B 640 and a BTS B 650 are associated with a BSC B 635. The TRAU B 640 includes a TFO_Protocol part 642, a Downlink_TFO (DL_TFO) part 644, and an encoder 646. The BTS B 650 is in radio communication with the MS B 655.

In non-TFO, signals are encoded at the MS A 605, transmitted over the air interface to the BTS A 610, decoded by decoder 626 at the TRAU A 620, and then forwarded over the links of the digital network 630. When the signal reaches the TRAU B 640, the signal is encoded by encoder 646 and sent over the air interface by the BTS B 650 to the MS B 655, where the signal is decoded. When in TFO, on the other hand, the TFO_Protocol part 622 causes the encoded signal received at the BTS A 610 to be routed through the UL_TFO part 624, thereby bypassing the decoding process in the decoder 626 of the TRAU A 620. After propagating through the digital network 630, the (still) encoded signal is routed through the DL_TFO part 644 by the TFO_Protocol part 642 to avoid the encoding process of the encoder 646. The (still) encoded signal may then be transmitted over the air interface by the BTS B 650 to the MS B 655, where it may be decoded. Signals from the MS B 655 to the MS A 605 may be sent in the reverse direction using TFO as well. Advantageously, an entire decoding and encoding process pair are obviated. When using TFO signaling, indicating the priority level of transmissions (e.g., identifying the non-interactive speech calls) may be accomplished by using the IS_System_Identification_Block.

Referring now to FIGURE 6B, an exemplary tandem free operation request message is illustrated generally at 660. The TFO request message 660 includes the following blocks: a header block 662, a request block 664, an IS_System_Identification_Block 665, a TFO request extension block 668, and a codec list extension block 669. The IS_System_Identification_Block 665 is illustrated as containing a GSM identification, but other system and/or standards may alternatively be identified. A particular bit pattern of no more than 20 bits identifies the GSM standard in this exemplary request message.

Referring now to FIGURE 6C, an exemplary tandem free operation acknowledgment message is illustrated generally at 670. The TFO acknowledgment message 670 includes the following blocks: a header block 662, an acknowledgment block 674, an IS_System_Identification_Block 665, a TFO acknowledgment extension block 678, and a codec list extension block 669. The IS_System_Identification_Block 665 is illustrated as containing a GSM identification, but other system and/or standards may alternatively be identified.

Referring now to FIGURE 6D, an exemplary tandem free operation request message with a priority level indication in accordance with the present invention is illustrated generally at 680. In the TFO request message 680, the IS_System_Identification_Block 665 is populated by a priority level indication 685. The priority level indication block 685 may include, for example, bit patterns corresponding to various priority levels, such as, e.g., interactive speech and non-interactive speech.

Referring now to FIGURE 6E, an exemplary tandem free operation acknowledgment message with a priority level indication in accordance with the present invention is illustrated generally at 690. In the TFO acknowledgment message 690, the IS_System_Identification_Block 665 is populated by a priority level indication 695. The priority level indication block 695 may include, for example, bit patterns corresponding to various priority levels, such as, e.g., interactive speech and non-interactive speech. These priority level indicating bit patterns may be identical to those of the priority level indication block 685 in a preferred embodiment.

Thus, in one embodiment, a priority analyzer (as part of, in conjunction with, etc. a TFO_Protocol part) extracts the priority level blocks 685/695 (e.g., to read the "system" type) and analyzes the bit patterns to determine the relative priority levels. By way of example and not limitation, if a first set of packets have bit patterns corresponding to interactive speech and a second set of packets have bit patterns corresponding to non-interactive speech, then the first set of packets is forwarded to a latter stage while the second set is delayed until the first set is forwarded.

Although preferred embodiment(s) of the method and system of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the present invention is not limited to the embodiment(s) disclosed, but is capable of numerous rearrangements, modifications, and substitutions without departing from the spirit and scope of the present invention as set forth and defined by the following claims.

WHAT IS CLAIMED IS:

1. A method for the prioritized transmission of information units, comprising the steps of:

receiving a first information unit, said first information unit including a first priority indication, said first priority indication comprising at least one of an interactive speech indication and a non-interactive speech indication;

analyzing said first priority indication; and

forwarding said first information unit responsive to said first priority indication analyzed in said step of analyzing.

2. The method according to Claim 1, further comprising the steps of:

receiving a second information unit, said second information unit including a second priority indication, said second priority indication comprising at least one of said interactive speech indication and said non-interactive speech indication;

analyzing said second priority indication; and

delaying a forwarding of said first information unit with respect to said second information unit when said first priority indication comprises said non-interactive speech indication and said second priority indication comprises said interactive speech indication.

3. The method according to Claim 1, wherein said first information unit comprises a packet.

4. The method according to Claim 1, wherein said first information unit comprises a speech frame in a communications system.

5. The method according to Claim 1, wherein said non-interactive speech indication comprises a correspondence to at least one of voice mail speech, recorded announcement messages, computer-generated menu options, speech recognition samples, e-mail to/from speech, and network-supported, voice-initiated dialing input.

6. The method according to Claim 1, wherein said step of analyzing said first priority indication further comprises the step of analyzing a block in a tandem free operation message.

7. The method according to Claim 6, wherein said step of analyzing a block in a tandem free operation message further comprises the step of analyzing a 20-bit block that may include a system identification indication.

8. The method according to Claim 1, wherein said step of forwarding said first information unit responsive to said first priority indication analyzed in said step of analyzing further comprises the step of routing said first information unit to an output interface when said first priority indication comprises said interactive speech indication.

9. The method according to Claim 1, wherein said step of forwarding said first information unit responsive to said first priority indication analyzed in said step of analyzing further comprises the step of delaying said first information unit prior to routing said first information unit to an output interface when said first priority indication comprises said non-interactive speech indication.

10. A router for prioritizing the transmission of information units, comprising:

a memory for receiving a plurality of information units, said plurality of information units including a first information unit, said first information unit having at least one speech priority indicator;

a priority analyzer for analyzing said at least one speech priority indicator of said first information unit and for producing a control signal; and

an information unit transmitter for forwarding said first information unit responsive to said control signal.

11. The router according to Claim 10, wherein said priority analyzer and said information unit transmitter comprise, at least in part, at least one software module.

12. The router according to Claim 10, wherein the router comprises at least a part of a base transceiver station in a wireless network system.

13. The router according to Claim 12, wherein said memory receives said plurality of information units from at least one transceiver of said base transceiver station in said wireless network system.

14. The router according to Claim 10, wherein said at least one speech priority indicator comprises at least one of interactive speech and non-interactive speech.

15. The router according to Claim 14, wherein said non-interactive speech priority indicator comprises a correspondence to at least one of voice mail speech, recorded announcement messages, computer-generated menu options, speech recognition samples, e-mail to/from speech, and network-supported, voice-initiated dialing input.

16. The router according to Claim 10, wherein said priority analyzer is operable to extract information from a system identification block of a tandem free operation information unit.

17. The router according to Claim 10, wherein said control signal produced by said priority analyzer prompts said information unit transmitter to retrieve said first information unit from said memory and route said first information unit to an output interface.

18. The router according to Claim 17, wherein said priority analyzer produces said control signal when said at least one speech priority indicator comprises a correspondence to interactive speech.

19. The router according to Claim 10, wherein said priority analyzer does not produce said control signal when said at least one speech priority indicator comprises a correspondence to non-interactive speech.

20. The router according to Claim 10, wherein said memory comprises a plurality of memory queues.

21. A format for an information unit that is interpretable by a communication network in order to prioritize routing, comprising:

a destination block, said destination block providing a target address;

an information block, said information block including speech information; and

a priority indication block, said priority indication block indicating the relative priority of information units responsive to a type of said speech information.

22. The information unit format according to Claim 21, wherein said priority indication block includes at least one of an interactive speech indicator and a non-interactive speech indicator responsive to said type of said speech information comprising interactive speech and non-interactive speech, respectively.

23. The information unit format according to Claim 22, wherein said non-interactive speech comprises at least one of voice mail speech, recorded announcement messages, computer-generated menu options, speech recognition samples, e-mail to/from speech, and network-supported, voice-initiated dialing input.

24. The information unit format according to Claim 22, wherein said interactive speech comprises a conversation between at least two people in real time

and said non-interactive speech comprises at least some types of verbal communication involving a single person in real time.

25. The information unit format according to Claim 21, wherein said priority indication block comprises at least a portion of a tandem free operation message.

26. The information packet format according to Claim 25, wherein said priority indication block comprises at least a part of a system identification block of said tandem free operation message.

27. A method for the prioritized transmission of information units, comprising the steps of:

receiving a first information unit, said first information unit including a first priority indication, said first priority indication comprising at least one of an interactive speech indication and a non-interactive speech indication;

analyzing said first priority indication;

receiving a second information unit, said second information unit including a second priority indication, said second priority indication comprising at least one of said interactive speech indication and said non-interactive speech indication;

analyzing said second priority indication; and

delaying a forwarding of said first information unit with respect to said second information unit when said first priority indication comprises said non-interactive speech indication and said second priority indication comprises said interactive speech indication.

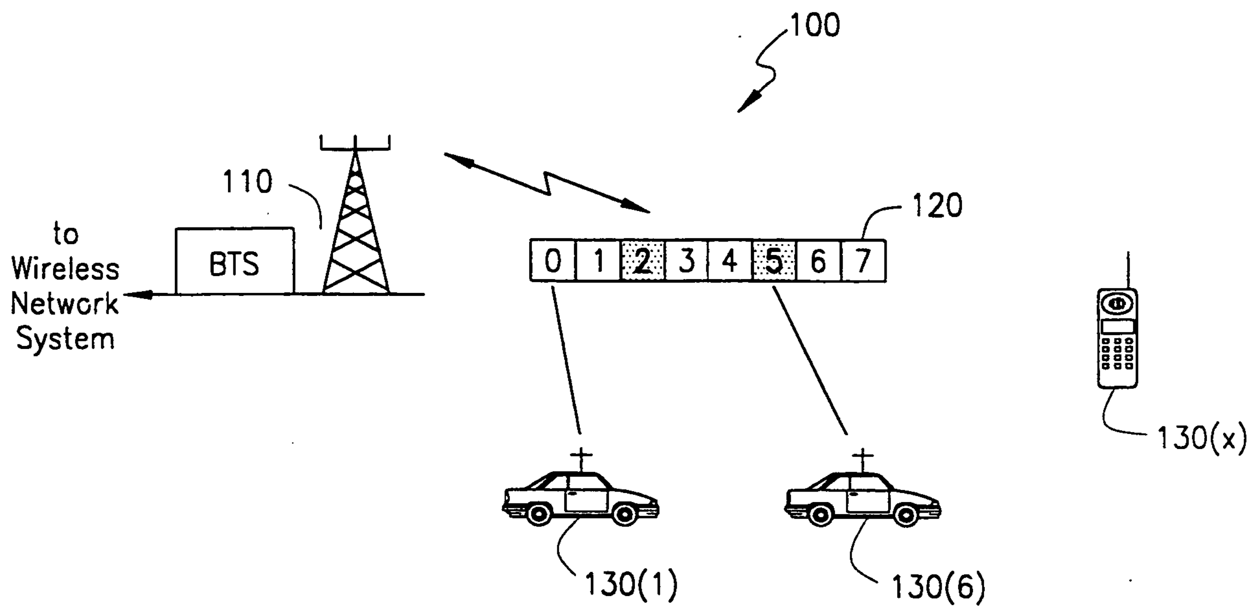
100
110
to
Wireless
Network
System
BTS
120
0 1 2 3 4 5 6 7
130(x)
130(1)
130(6)

FIG. 1

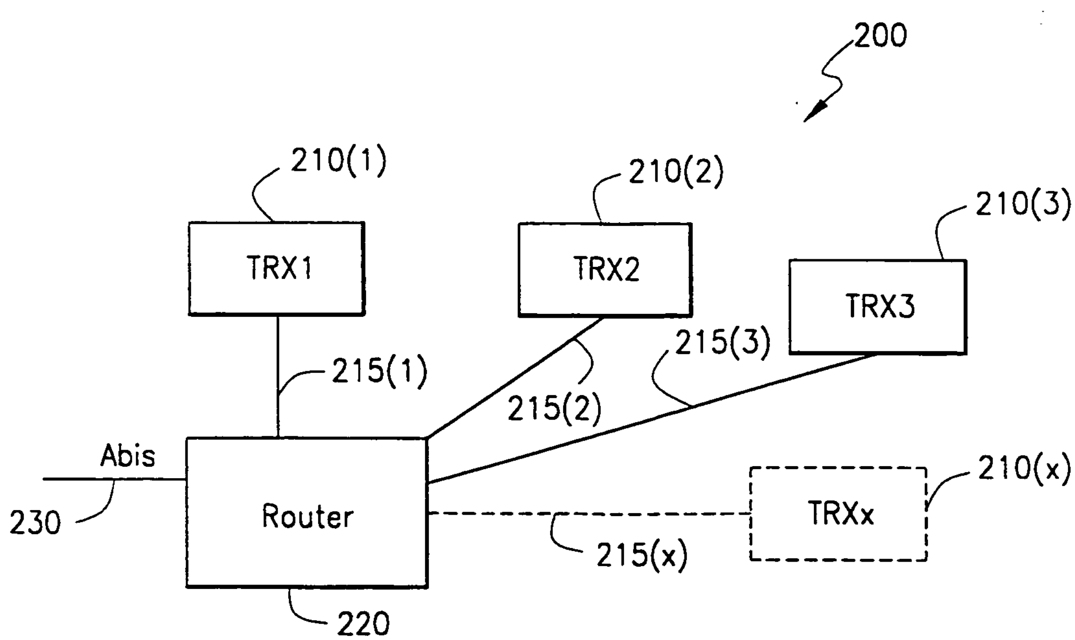
200
210(1)
210(2)
210(3)
TRX1
TRX2
TRX3
215(1)
215(2)
215(3)
Abis
230
Router
220
TRXx
210(x)
215(x)

FIG. 2

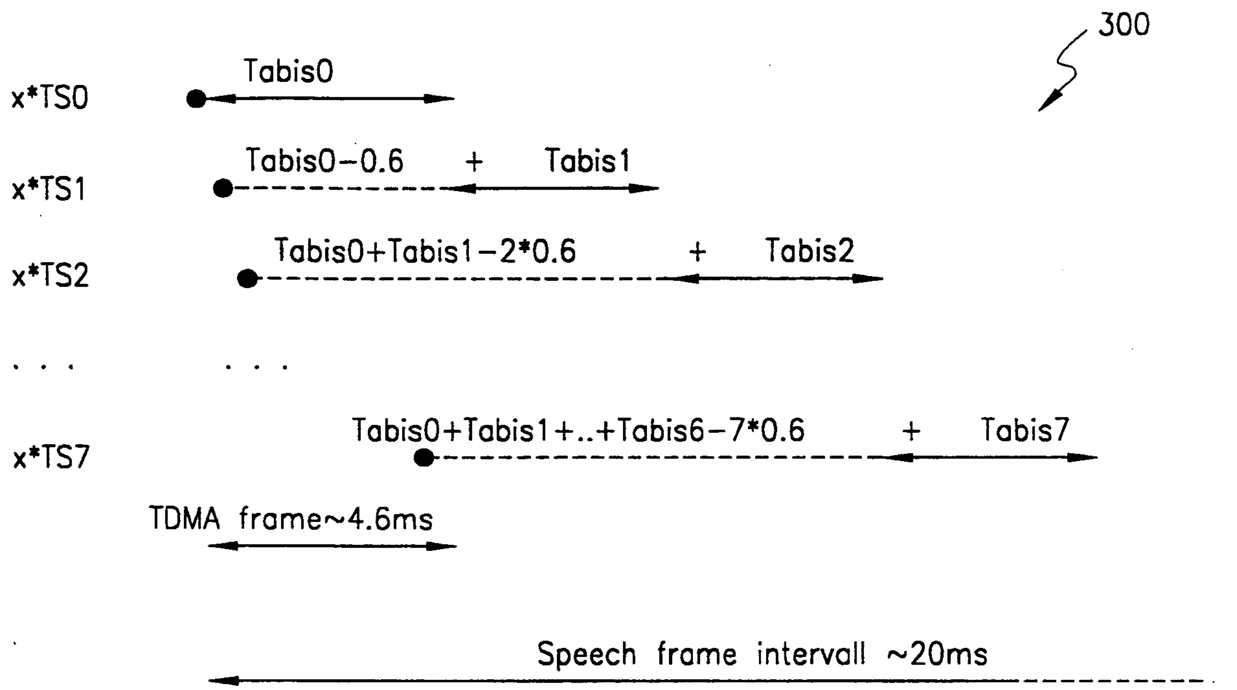
300
x*TS0
Tabis0
x*TS1
Tabis0-0.6 + Tabis1
x*TS2
Tabis0+Tabis1-2*0.6 + Tabis2
. . .
. . .
x*TS7
Tabis0+Tabis1+..+Tabis6-7*0.6 + Tabis7
TDMA frame~4.6ms
Speech frame intervall ~20ms

FIG. 3A

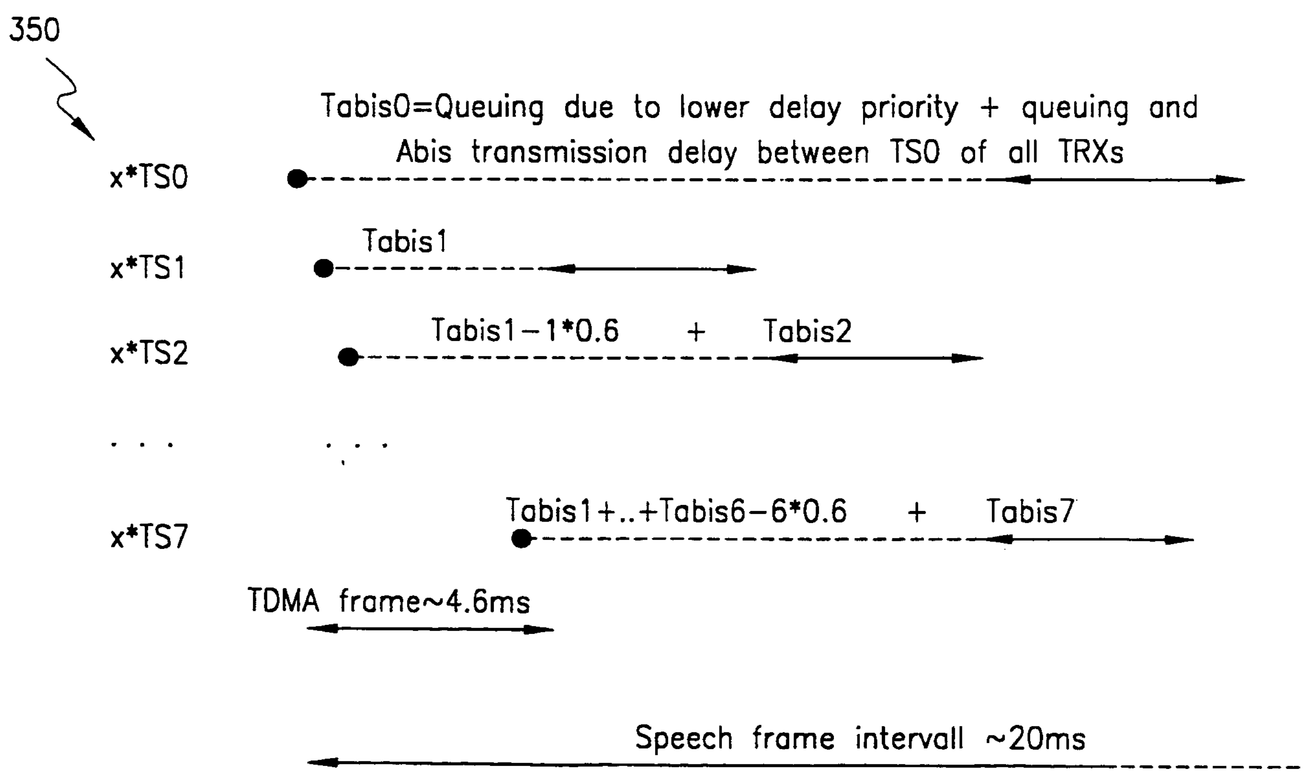
350
Tabis0=Queuing due to lower delay priority + queuing and
Abis transmission delay between TS0 of all TRXs
x*TS0
x*TS1
Tabis1
x*TS2
Tabis1-1*0.6 + Tabis2
. . .
. . .
x*TS7
Tabis1+..+Tabis6-6*0.6 + Tabis7
TDMA frame~4.6ms
Speech frame intervall ~20ms

FIG. 3B

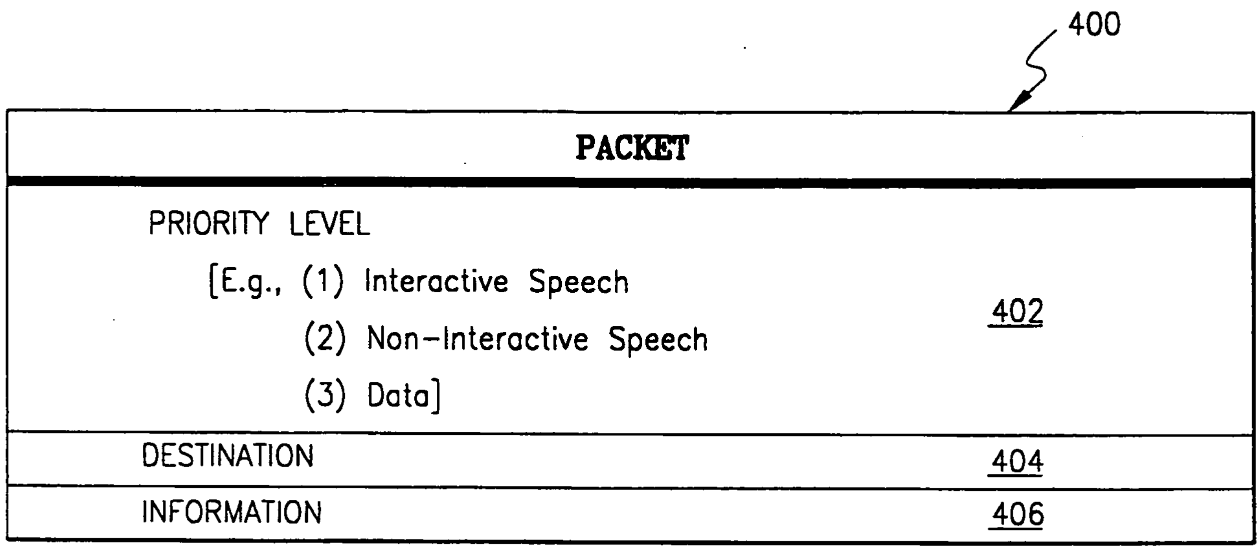
400
PACKET
PRIORITY LEVEL
[E.g., (1) Interactive Speech
(2) Non-Interactive Speech
(3) Data]
402
DESTINATION
404
INFORMATION
406

FIG. 4A

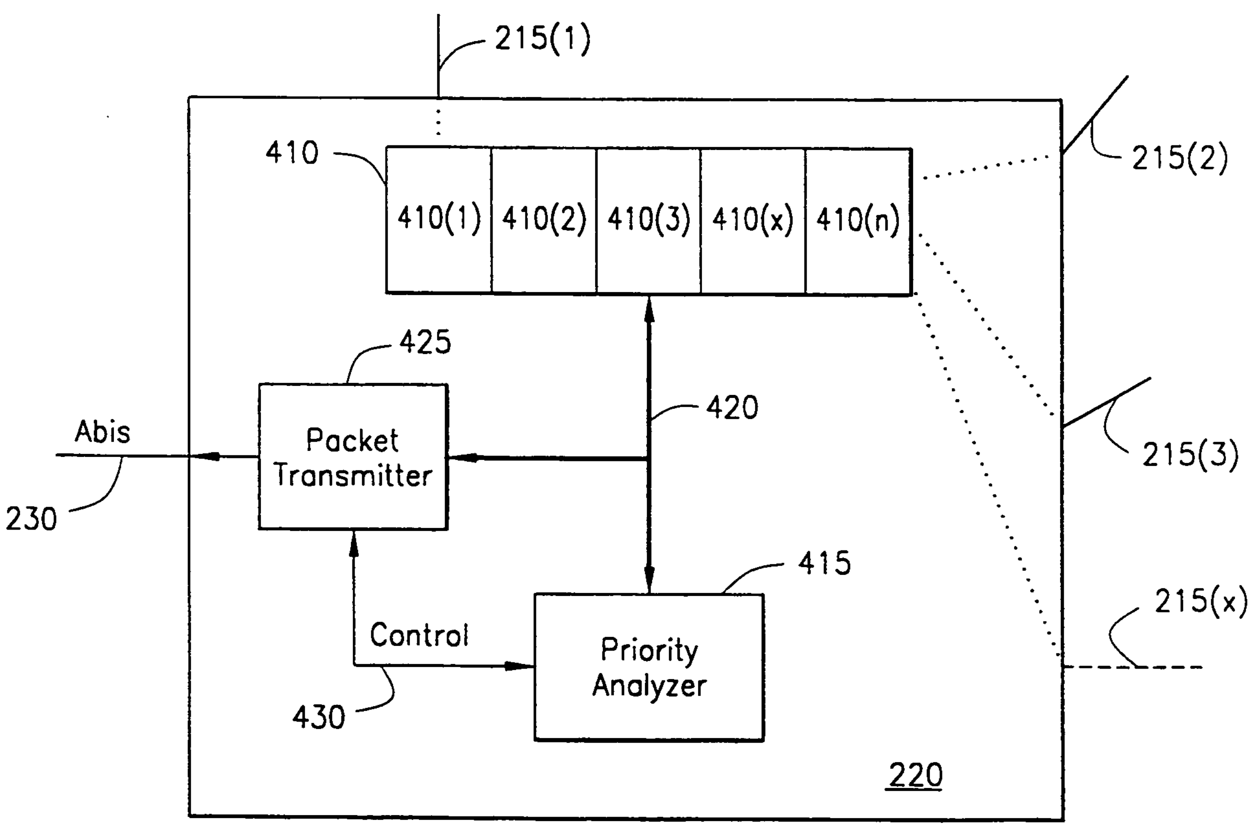
215(1)
410
410(1)
410(2)
410(3)
410(x)
410(n)
215(2)
425
420
Abis
Packet
Transmitter
215(3)
230
415
215(x)
Control
Priority
Analyzer
430
220

FIG. 4B

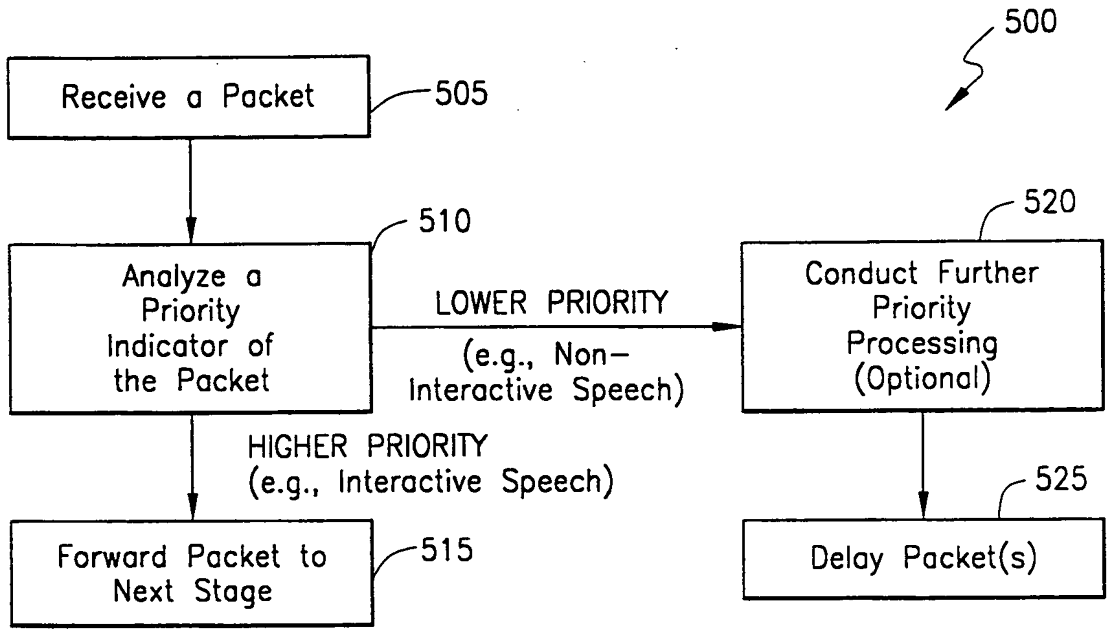

FIG. 5

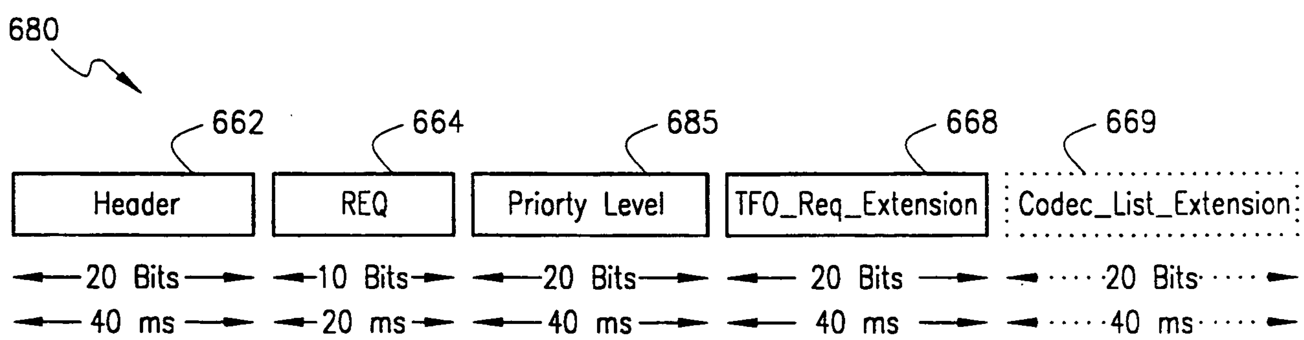

FIG. 6D

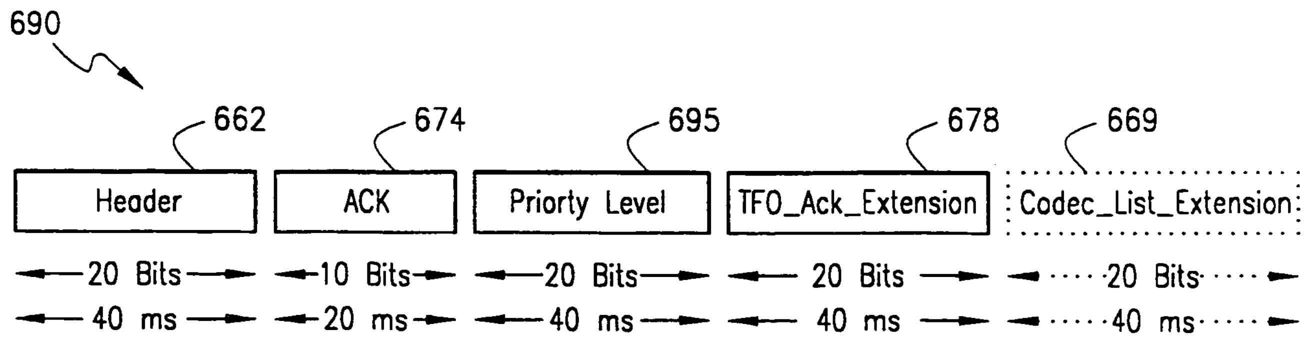

FIG. 6E

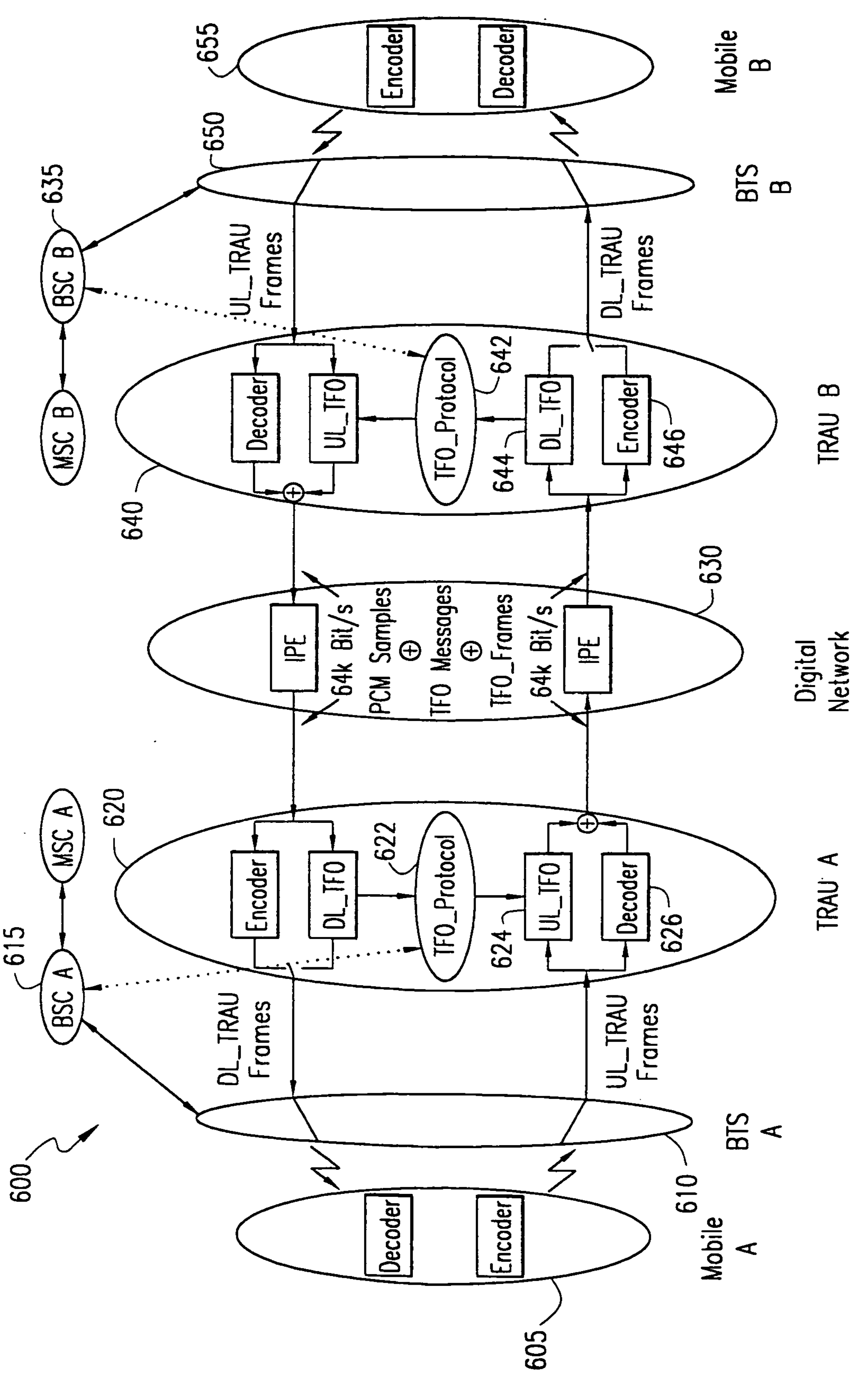
600
605
Mobile A
Decoder
Encoder
610
BTS A
DL_TRAU Frames
UL_TRAU Frames
615
BSC A
MSC A
620
TRAU A
Encoder
DL_TFO
622
TFO_Protocol
624
UL_TFO
Decoder
626
IPE
64k Bit/s
PCM Samples
⊕
TFO Messages
⊕
TFO_Frames
64k Bit/s
IPE
630
Digital Network
640
TRAU B
Decoder
UL_TFO
TFO_Protocol
642
DL_TFO
644
Encoder
646
MSC B
BSC B
635
UL_TRAU Frames
DL_TRAU Frames
650
BTS B
655
Mobile B
Encoder
Decoder

FIG. 6A

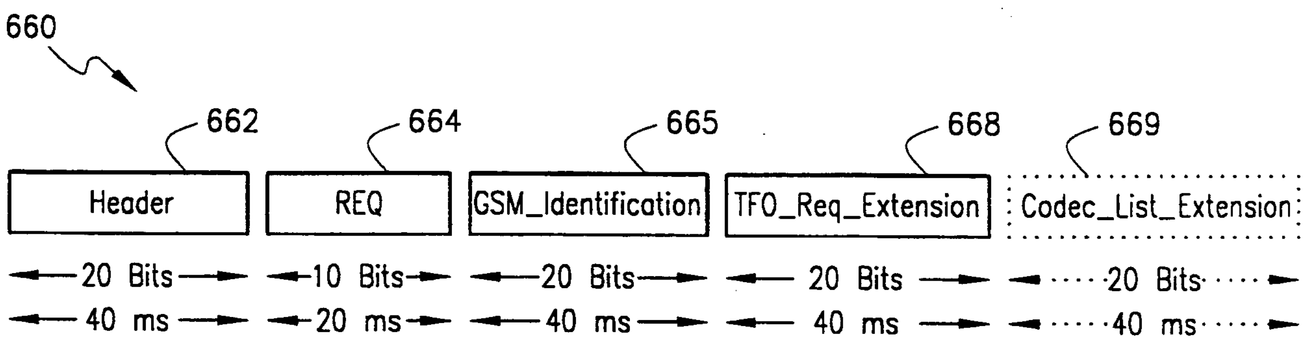
660
662
664
665
668
669
Header
REQ
GSM_Identification
TFO_Req_Extension
Codec_List_Extension
20 Bits
10 Bits
20 Bits
20 Bits
20 Bits
40 ms
20 ms
40 ms
40 ms
40 ms

FIG. 6B

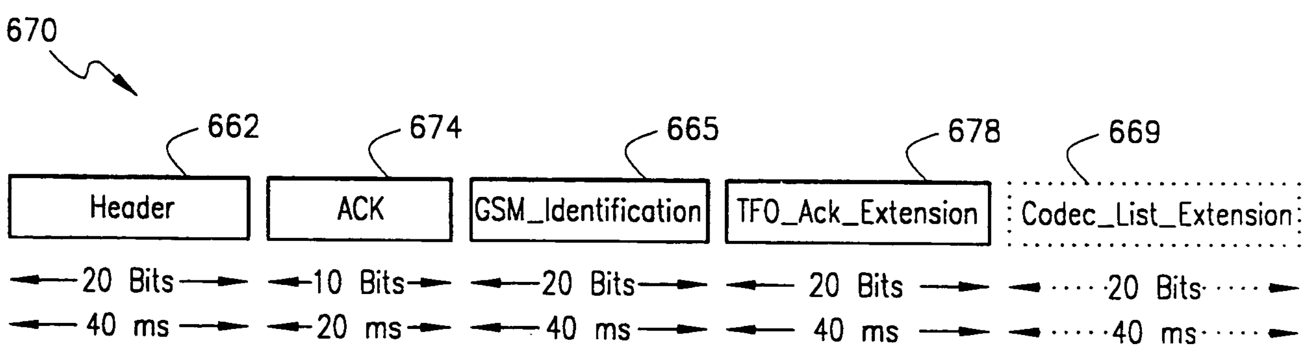
670
662
674
665
678
669
Header
ACK
GSM_Identification
TFO_Ack_Extension
Codec_List_Extension
20 Bits
10 Bits
20 Bits
20 Bits
20 Bits
40 ms
20 ms
40 ms
40 ms
40 ms

FIG. 6C

INTERNATIONAL SEARCH REPORT

Int ational Application No
PCT/SE 99/02408

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 36405 A (NOKIA TELECOMMUNICATIONS OY ;HUUSKO SAMI (FI); KARI HANNU H (FI)) 2 October 1997 (1997-10-02) page 1, line 34 -page 2, line 32 page 3, line 26 -page 4, line 11 page 4, line 30 - line 34 page 6, line 1 - line 9 page 8, line 1 - line 15	10-15, 17-20,27
Y		1-5,8,9, 21-24

Y	US 4 707 831 A (WEIR DECEASED DONALD A ET AL) 17 November 1987 (1987-11-17) abstract figure 2 column 1, line 1 - line 35	1-5,8,9, 21-24

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 June 2000	03/07/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dionisi, M

INTERNATIONAL SEARCH REPORT

Int ational Application No
PCT/SE 99/02408

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 608 (E-1633), 18 November 1994 (1994-11-18) & JP 06 232904 A (HITACHI LTD), 19 August 1994 (1994-08-19) abstract -----	10,11, 14,17,20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/SE 99/02408

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9736405 A	02-10-1997	FI 961363 A	26-09-1997
		AU 2162097 A	17-10-1997
		CA 2250040 A	02-10-1997
		CN 1214832 A	21-04-1999
		EP 0886938 A	30-12-1998
US 4707831 A	17-11-1987	GB 2166320 A	30-04-1986
		EP 0179629 A	30-04-1986
		FR 2572606 A	02-05-1986
		JP 61129952 A	17-06-1986
JP 06232904 A	19-08-1994	NONE	

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